mainder being opposed by the reaction of molecular elasticity. Maxwell[*] has suggested a crucial experiment of a similar character to the one I then sought. The velocity of his electrified disc bears nearly the same ratio to Earth's orbital velocity, as the diminution of terrestrial attraction by equatorial centrifugal force (or actual energy of superficial gravity) bears to the total attraction. The magnetic disturbance of the disc : Earth's horizontal magnetic force : : the molecular *vis viva* [†] of equatorial rotation : the molecular *vis viva* of orbital revolution.

The molecular oscillation, in alternate approach to and recess from the orbital centre, continues for a half-rotation or a half-revolution, while the terrestrial antagonism lasts only $\dfrac{1}{\pi}$ as long. If we distinguish the terrestrial from the solar units by subscript accents, $l_i = l$; $t_i = \dfrac{t}{\pi}$; and, if magnetism and gravitation are tidally related, Maxwell's data[‡] may be represented by the following proportionate tensions :

$m_i{}^2 \, l_i{}^2 \, t_i{}^{-4} : m^2 l^2 t^{-4} : : m_i{}^2 \pi^4 : m^2 : : .128 : 140 \times 144 \times 7000 : : 1 : 1102500000.$ Then $m_i{}^2 : m^2 : : 1 : 1102500000 \pi^4$, and $m = 327710 \, m_i$. This gives a solar parallax of $\sqrt[3]{\dfrac{10^9}{4.432 m}} = 8''.83$, which is $\frac{1}{3}$ of one per cent. less than Cornu's parallax.

PLANETARY ILLUSTRATIONS OF THE CREATIVE FIAT.

By Pliny Earle Chase.

(Read before the American Philosophical Society, Aug. 20, 1875.)

In various communications to the American Philosophical Society and to the American Association, I have shown that—

1. The same principles of inertia which cause the Foucault pendulum to record the Earth's rotation, also register the Sun's influence, in sound waves, barometric waves, magnetic variations, mean temperatures, nascent velocities both chemical and cosmical, solar and planetary masses and moments, and stellar and planetary harmonies of relative position, rotation, and revolution.

2. Various independent inertia-estimates of solar distance may be thus obtained, differing from Cornu's final estimate in amounts varying between $\frac{8}{40}$ of one per cent. and $\frac{7}{10}$ of one per cent.

3. All the physical activities which I have tested, seem explicable by æthereal waves, propagated with the velocity of light.

4. Between *a Centauri* and the Sun a parabola can be traced, governed by the solar modulus of light, and determining planetary positions..

[*] Op. Cit., ii, 370.

[†] The influence of molecular *vis viva* was shown in my discussion of barometric tides, (*ante*, ix, 287). Imray also recognizes its importance in elevating the centre of the molecule, in wave movement, above the normal level, (Proc. Roy. Soc., No. 153, pp. 352–3).

[‡] Ib., ii, 258.

5. In studying the phenomena of exploding hydrogen and oxygen, in order to determine the comparative reaction of Earth and Sun upon the disturbed inertia, and their consequent relative masses, it is necessary to consider the "centres of explosive oscillation," at $\frac{4}{9}$ and $\frac{5}{9}$ of the total excursion of particles from either extremity.

6. In all perpetual movements of mutual alternate approach and regress, there is a double tendency towards centres of gravity and centres of linear oscillation, due to the action of centripetal and centrifugal equilibrating forces, analogous to the tendency in simple explosion.

7. Consequently the ratios $\frac{4}{9}$ and $\frac{5}{9}$, $[(\frac{2}{3})^2$ and $1-(\frac{2}{3})^2]$, are found largely prevalent in planeto-taxis.

8. Rotation and orbital revolution are due to the operation of the same forces, rotation being merely revolution retarded by internal pressure.

9. The velocity of rotation varying inversely as radius, while the velocity of revolution varies inversely as the square-root of radius, the two velocities, in a cooling and shrinking mass, tend to approximate equality. If matter were infinitely divisible, or if the theory of Boscovich were true, they would finally become equal, and, if shrinkage still continued, the preponderating centrifugal force of rotation would lead to disintegration.

10. Whatever may be the ultimate constitution of matter, the internal resistances of heat-volume, mass-inertia, and other interferences of known and unknown forms, must be the same in the aggregate as if the theory of Boscovich were true. Therefore, by finding the limits of equality in accordance with that theory, we may find the limiting velocities of the primitive force.

11. Those limits may be studied tangentially, by comparing the equatorial velocity of rotation, with the velocity of circular revolution at the same point $\left(\sqrt{gr}\right)$; radially, by comparing the velocity acquired through fall from an infinite distance, $\left(\sqrt{2\,gr}\right)$, with the mean velocity of radial oscillation due to rotation and synchronous with it $\left(\frac{2}{\pi}\right.$ of the velocity of rotation$\left.\right)$. At the points of equality, the former limit marks the boundary between complete aggregation and commencing dissociation ; the latter, between complete dissociation and commencing aggregation.

12. Calculating these limits for the principal bodies of the solar system, we find that complete dissociation would take place in all the subordinate planets before their rotation-speed had increased to the limiting velocity of aggregation in Earth and Jupiter ; complete dissociation would take place in Earth and Jupiter, when their rotation-speed had attained the present limit of possible circular revolution, at the centre of gravity of Sun and Jupiter ; the limit of solar aggregation is $\frac{1}{\pi}$ of the velocity of light ; the potential of solar attractive force would give the velocity of light ; the limit of solar dissociation is the velocity of light ; the limit of planetary dissociation would carry a particle around the Sun while a ray of light was passing from the orbit of Uranus, through Sun,

to Earth's orbit, a distance equivalent to $\frac{2}{3}$ Neptune's mean radius vector, or to the true length of the linear pendulum of Sun's outermost planet; the time-ratio of Earth's rotation to Jupiter's revolution, is the same as the ratio of Sun's radius to the primary pendulum.

Combining these several results with the accordances of electrical velocity and chemical affinity, which have been discovered by Weber and Kohlrausch, Thomson, Clerk Maxwell, and Edlund, and with the explosive energy of hydrogen, which brings all chemical attraction into simple correlation with gravitating attraction, we find a profound scientific truth in the doctrine that the first act of creation was the Divine command, LET THERE BE LIGHT.

La Place's calculation that gravitating action involved a velocity at least six million times as great as that of light, may, perhaps, as President Lovering well suggested in his Hartford address, require revision in order to make allowance for additional data. In a substance, either of infinite elasticity, or of no density, (and, therefore, spiritual?) undulations would be propagated with infinite velocity. It is easily conceivable, either that the transverse vibrations of luminous waves, which have been studied, are accompanied by co-ordinate undulations of much greater speed, which have hitherto escaped notice, or that there is some other kind of motion to be considered than that of simple undulation. In a medium for the transmission of force, endowed with immense elasticity and with such slight mobility of particles as Fresnel supposed, may there not be a quasi rigidity in "lines of force" when compared with such low stresses as those of tidal influence, which will account both for the rapidity of gravitating action, and for the more than steel-like firmness which Sir Wm. Thomson attributes to the Earth's mass? The greatest possible manifestation of gravitating velocity in the solar system, $\sqrt{2\ gr}$, is equivalent to that communicated by virtual fall, at Sun's surface, in 2255 seconds. Since this velocity is only $\frac{1}{486.7}$ as great as the velocity of light, and since there are 103 (10)^{16} waves in 2255 seconds, only $\dfrac{1}{501\ (10)^{18}}$ of the velocity of its own transmission need be imparted by each wave for producing the ultimate aggregate of gravitating motion.

Looking still further into the internal constitution of the solar system, we find that the angular velocity of revolution at twice Neptune's distance, equals the angular velocity of rotation due to a solar radius extending to Mercury's mean distance, a coincidence suggesting probable asteroidal or planetary masses beyond Neptune in a way similar to my harmonic indication of matter within Mercury's orbit, revolving in a time, which was subsequently confirmed by the Sun-spot observations of De La Rue, Stewart, and Loewy. Inasmuch as the velocity communicated by infinite fall to any radius vector, equals the velocity of circular revolution at half that radius, this accordance seems to have fixed the limits of the planetary belts. Within those limits, planetary positions may be referred to simple circular pendulums, which are so related that their harmonic vi-

brations tend to maintain the stability of the system. The pendulum unit is $\frac{9}{4}$ Sun's radius, Sun's surface being at a centre of explosive oscillation.

The time of rotation for a given radius varying as the $\frac{4}{3}$ power of the time of revolution for the same radius, the theoretical distance of each planet may be found by multiplying the $\frac{4}{3}$ power of its number of pendulum units by the value of the unit. Symbolizing each pendulum by its planet's initial letters, the following table gives a comparison of theoretical and actual mean distances. The second column *exactly* represents planetary positions, although, on account of orbital eccentricities and mutual perturbations, it only represents *mean* positions with a very close approximation.

	No. of Pend. Units.	(A) Theoretical Mean Distance.	(B) Actual Mean Distance.	(A–B) ÷ (B)
Me.	15	83.23	83.17	+ .0007
Ve.	24	155.76	155.42	+ .0022
Ea.	30	209.74	214.86	— .0239
Ma.	42	328.48	327.38	+ .0034
Ju.	105	1114.75	1117.87	— .0028
Sa.	168	2085.75	2049.51	+ .0177
Ur.	280	4121.54	4121.78	— .0001
Ne.	392	6455.03	6453.06 ·	+ .0003

The pendulum orbits may be referred to extremities, or to centres of oscillation of linear pendulums, as follows :

	Ex.	*c. o.*	*c. o.*	*Ex.*
1.	Ne.	Ur.	Sa.	Sa. c. o. (= $\frac{1}{3}$ Sa.)
2.	Sa.	Ju.	Ma.	⊙ Ma. c.g. (= $\frac{1}{2}$ Ma.)
3.	Ma.		Ea.	Ve.
4.	Ma.		Ve.	Me.
5.	Ea.	Me.	⊙	Me.
6.	Ve.	$\frac{1}{2}$ Ma.		Me.

Each of the divisions of the first pendulum is equivalent to the diameter of a Sun extending to the centre of oscillation of Sa., and the pendulum orbit is symmetrically divided on both sides of the Sun.

Each of the divisions of the second pendulum is equivalent to a pendulum, of which Sun occupies a centre of oscillation, and Mars a centre of vibration.

If all physical force is transmitted through the medium of an elastic æther, the foregoing accordances seem to illustrate the well-known law, that where points of gross inertia are established in an elastic medium, and exposed to undulations from every direction, as the distances increase in arithmetical progression the densities decrease in harmonic progression.